This is a representative sample of an approved waiver application for 14 CFR § 107.29

WSEG Question #1:

- **Describe how the Remote Pilot in Command (RPIC) will maintain visual line of sight (VLOS) during darkness.**
    - **In order to address this the FAA has provided the following questions as part of the Waiver Application Guidance (WAG) to assist the applicant in addressing this WSEG:**
        - **How will the RPIC be able to see the sUA in the dark, at the maximum planned distance from the RPIC and/or VO?**
        - **What procedures will the RPIC and/or VO follow if they lose sight of the sUA in the dark?**

The factory provided lighting on the sUA does not provide sufficient lighting to allow the Remote PIC and Visual Observer (VO) to maintain positional awareness of the aircraft at night. To overcome this limitation, the aircraft has been equipped with high visibility position and anti-collision lighting. These are ultra-bright LED position lights can be seen by the Remote PIC and VO for at least 1 mile. The anti-collision lighting is visible for 3 miles. The position lights are arranged in the same configuration as manned aircraft with one red light on the left and one green light on the right. The white anti-collision light is located on the top of the aircraft. This location provides at least 3 miles visibility to manned aircraft.

The maximum distance to be flown at night will not exceed three hundred horizontal feet, and the actual distance flown will be restricted to VLOS. In the operations area, and particularly mountainous areas, the flight distances will be considerably shorter.

In the event of a partial or complete lighting system failure, the aircraft's forward progress will be halted and the aircraft placed in a hover. The Remote PIC will immediately notify the flight crew to terminate the mission and then return the aircraft to the closest designated landing area. The Ground Control Station (GCS) is equipped with a display that the Remote PIC will use to determine the aircraft's location, orientation, altitude and airspeed. Since visual awareness of the aircraft's position is compromised, there is a risk of the aircraft hitting an obstruction on the return flight. To minimize this risk, the Remote PIC will always maintain a clear fight path to a pre-designated landing area during normal operations. The primary and alternate landing areas are selected during pre-mission surveys to allow a clear flight path in the event of an emergency. The

VO will verify that the designated landing area is clear and then notify the Remote PIC. If the area is not clear, the alternate landing area will be used.

If the Remote PIC loses sight of the aircraft, they will immediately notify the VO. The aircraft's forward progress will be halted and the aircraft placed in a hover. The VO will assist the Remote PIC in visually reacquiring the aircraft by providing the location of the aircraft relative to the Remote PIC's location. If the Remote PIC reestablishes visual line of sight, the operation will continue. If the Remote PIC still cannot visually reestablish the aircraft, he will use the aircraft's distance, altitude, direction of travel and relative position data from the GCS to help visually reacquire the aircraft. If that fails, then this will be treated the same as a lighting system failure (see above) and the mission will be terminated.

If the VO loses sight of the aircraft, he will immediately notify the remote PIC. The aircraft's forward progress will be halted and the aircraft placed in a hover. The Remote PIC will then assist the VO in visually reacquiring the aircraft by first providing the VO with the location of the aircraft relative to the VO's location and then, if needed, maneuvering the aircraft to a location that will allow the VO to visually reacquire the aircraft. If the VO reestablishes visual line of sight, the operation will continue. If the VO still cannot visually reestablish the aircraft's location, then this will be treated the same as a lighting system failure (see above) and the mission will be terminated.

WSEG Question #2:

- **Describe how the RPIC will see and avoid other aircraft, people on the ground, and ground-based structures and obstacles during darkness.**
    - **In order to address this the FAA has provided the following questions as part of the Waiver Application Guidance (WAG) to assist the applicant in addressing this WSEG:**
        - **How will the RPIC and/or VO locate other persons, aircraft and structures in the dark?**
        - **What will they do if other persons/aircraft are located during flight?**
        - **How will they avoid hitting obstacles/structures during flight?**
        - **If flight operations occur in an area with lighting sufficient for the RPIC and VO to see the sUA, and other obstacles, persons and aircraft, how will they determine the lighting is sufficient before flight?**

Ensuring a clear flight path that is free from obstructions, other aircraft and people is critical for safe low light and nighttime flight operations. This is accomplished by using a combination of preflight planning, specially trained flight crew and nighttime protocols. The preflight planning process uses a daylight survey of the area of operation that is conducted within 48 hours of the operation. Obstructions and nearby structures are identified and documented. Flight paths and landing areas which maintain a safe distance from those obstacles and structures are then created. When determining the minimum

safe distances, anticipated maximum wind, airspeed and altitude are taken into account. The flight paths are then practiced during daylight hours. Landing areas are selected in locations away from non-participants and a 20' perimeter is established using high visibility caution tape. Low light and nighttime operations are never flown in an area where clear flight paths and landing areas cannot be established and maintained.

One or more VOs are used to assist the Remote PIC in locating and maintaining awareness of other aircraft and non-participants in the area. All crew members not collocated with the Remote PIC are equipped with two-way, full duplex, VHF radios to facilitate communications. The VOs provides the following safety awareness functions:

• Locating and tracking aircraft in the area using nighttime visual scanning techniques and by monitoring the Common Traffic Advisory Frequency (CTAF).

• Monitoring the operations area for non-participants and verifying the landing area is clear prior to mission termination. The VO's location is chosen to maximize the view of the sky and the landing area. If required, a second VO is used to ensure that both areas are monitored.

• Determining aircraft proximity to structures. If operations need to be conducted close to a structure, a dedicated VO is placed near the structure, providing the Remote PIC with a second perspective on the aircraft's position relative to the structure.

A nighttime operations lighting procedure has been established that allows for the flight crew's vision to adjust to the low light conditions and maintain dark adaptation. All crew members start this procedure a minimum of 20 minutes before flight operations begin. The protocol includes:

• Setting all video displays to minimal brightness

• Marking the primary landing area perimeter with four low intensity blue LED marker lights

• Using only dimmed red or blue lighting in the mission operation area

• Using dark sunglasses (ND15 or equivalent) when in normal lighting

If the RPC/VO observes an aircraft (manned or unmanned) approaching the search area, he/she will determine if corrective action is needed. The required action determination will be based on the observable position lights of the aircraft (red/left wing, green/right wing, white/rear of aircraft) and anti-collision lights (generally rotating/flashing red on top and bottom of aircraft), whether it is moving across their field of vision or seems stationary and altitude.

In the event that a manned aircraft encroaches on the flight operations area, the Remote PIC will yield the right of way to the manned aircraft by immediately reducing altitude if the manned aircraft is transient or by landing if the manned aircraft remains in the area.

If another unmanned aircraft enters the operational area, the RPIC will move the sUA to an area away from the other sUA until the area is cleared. If the area cannot be cleared, the operation will be terminated and the sUA landed in an area that is clear of people and the other sUA.

In all cases, the RPIC will immediately yield right-of-way to any other aircraft that may pose a collision risk in the area.

If non-participants are observed in the operations area, the aircraft is moved to an area away from the non-participants until the area is cleared. If the area cannot be cleared, the operation is terminated and the aircraft is landed in an alternate area that is free from non-participants.

To ensure the aircraft remains within the planned flight operations area, the ground control station is configured to limit the aircraft's maximum altitude (AGL) and distance from the landing area. Those parameters are specific to each operation and are determined during the preflight planning process.

WSEG Question #3:

- **Describe how the RPIC will be able to continuously know and determine the position, altitude, attitude and movement of the sUA.**
    - **In order to address this the FAA has provided the following questions as part of the Waiver Application Guidance (WAG) to assist the applicant in addressing this WSEG:**
        - **How will the RPIC be able to tell which direction the sUA is pointing or flying in the dark?**
        - **While keeping eyes on the sUA, how will the RPIC continuously know the current real-time (1) geographic location, (2) altitude above ground level, (3) attitude (orientation, deck angle, pitch, bank) and movement of the sUA?**

The sUA position lights are arranged in the same configuration as manned aircraft with one red light on the left and one green light on the right.

In the dark, the aircraft's direction of travel can be determined visually using the red and green position lights as follows:

• Red on the left, Green on the right - aircraft is heading away from the observer

• Red on the right, Green on the left - aircraft is heading toward the observer

The aircraft's orientation can be determined visually using the relative motion of the aircraft. With forward thrust applied,

• If the aircraft moves left, the aircraft is pointing left

• If the aircraft moves right, the aircraft is pointing right

• If the aircraft is not moving left or right, then turn the aircraft to the left.

• If the aircraft moves left, then the aircraft was pointing away from the observer and is now pointing left

• If the aircraft moves right, the aircraft was pointing toward the observer and is now pointing right

To increase the safety of the flight and provide increased situational awareness, the ground control station for the sUA provides real-time telemetry on aircraft battery level, geographic location (with map overlay), horizontal distance from the launch point, horizontal distance between the sUA and the RPIC, altitude (AGL), attitude, horizontal speed across the ground and direction of flight. The GCS is conveniently mounted on the aircraft's remote control unit and presents the data using a combination of voice alerts and a visual display (iPad mini). The location of the display allows the Remote PIC to quickly obtain the needed real-time data while maintaining visual awareness of the aircraft's position. For low light missions, the GCS display is set to minimum brightness and does not impact the Remote PIC eyes' adjustment to the dark. Critical warnings such as low battery, maximum altitudes and maximum distance are always established for each mission and are presented by the GCS with voice alerts.

WSEG Question #4:

- **What procedures will be followed to ensure all the required persons participating in the operation have knowledge to recognize and overcome visual illusions caused by darkness and understand physiological conditions which may degrade night vision.**
    - **In order to address this the FAA has provided the following questions as part of the Waiver Application Guidance (WAG) to assist the applicant in addressing this WSEG:**
        - **How will the RPIC and any other persons participating in the operation demonstrate knowledge about night operation risks, such as overcoming night visual illusions, limitations to night vision and conditions that can affect night vision?**
        - **How will participants obtain this knowledge and who will document it?**
        - **How will the RPIC verify it has been obtained and documented?**

The FAA Helicopter Flying Handbook (FAA-H-8083-21A, chapter 13), Airplane Flying Handbook (FAA-H-8083-3B, chapter 10) and Pilots Handbook of Aeronautical

Knowledge (FAA-H-8083-25B, chapter 17) provide detailed information on preparing for and conducting Night Operations. All crew members participating in low light or nighttime operations are required to read the Night Operations chapters and demonstrate their understanding of the material by passing a 20-question multiple choice written exam with a minimum score of 18. The PIC supervises the exams and retains all completed exams as documentation of proficiency. Crew member exam results are available upon request. In addition to learning the written material, all crew members participate in a hands-on training session as part of each low light mission briefing. The session covers a review of causes and remediation for night illusions, night adaptation procedures and a demonstration of proper nighttime visual scanning techniques.

All crew members operating under this waiver are required to complete biennial night vision training and testing as described above. A review of causes and remediation for night illusions, night adaptation procedures and a demonstration of proper nighttime visual scanning techniques is included as part of each mission briefing.

WSEG Question #5:

- **Describe how the visual conspicuity of the sUA will be increased to be seen at a distance of at least 3 statute miles (mi).**
    - **In order to address this the FAA has provided the following questions as part of the Waiver Application Guidance (WAG) to assist the applicant in addressing this WSEG:**
        - **Will the sUA be visible for at least 3 mi at night in the location where the RPIC will operate?**
            - **If yes, how will you accomplish this?**
            - **If no, why do other aircraft not need to be able to see your sUA from at least 3 mi?**

To make the sUA as conspicuous as possible, and in addition to the LED lights already on the aircraft, the aircraft is equipped with high intensity strobe lights. The strobes are tested and manufacturer specifications are to be visible up to 10 statute miles. As part of the checklist, the strobes will be checked to ensure they are properly charged prior to the mission, are properly installed on the aircraft during pre-flight